

STATUS, ECOLOGY AND CONSERVATION OF THE INDIAN WOLF *CANIS LUPUS PALLIPES* SYKES

(With two text-figures and one plate)

YADVENDRADEV JHALA¹

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Two wolf subspecies were believed to inhabit the Indian subcontinent, the Tibetan wolf (*Canis lupus chanco*) whose range extends from the trans-Himalaya into Tibet and China, and the Indian wolf (*Canis lupus pallipes*) that ranges over much of peninsular India. Recent genetic data shows three extant wolf lineages in the Indian subcontinent. Two of these, the Himalayan and peninsular lineages, are ancient and unique to the Subcontinent, while wolves from Kashmir belong to the widespread wolf-dog clade. The Indian wolf (peninsular clade) inhabits semi-arid agro-pastoral landscapes and scrub forests. It is considered endangered, with its numbers ranging between 2,000-3,000 individuals. Undisturbed habitat patches of 5-15 sq. km that offer good cover and water are critical for successful breeding in established packs. Wolf territories range between 150 and 300 sq. km and are a function of prey and denning habitat availability. Indian wolves whelp in December-January in an underground den excavated by the alpha pair. The mean litter size is 4.8 pups. Juvenile wolves can disperse from their natal pack after the age of 8 months. The majority of wolf populations in India survive outside protected areas, and subsist primarily on livestock. In some areas, wolves have been reported to attack children. The common factors in such areas are high human population, poverty, too few or heavily guarded livestock, and poor wild prey availability. Human-wolf conflicts are of serious magnitude over much of the wolf's range in India. Wolves are persecuted by smoking pups in their dens, sometimes by shooting and recently by poisoning. Major threats to the continued survival of wolves in India are persecution by poisoning, and loss of denning habitat to intensive agriculture, development, and industry.

INTRODUCTION

Canis lupus once had the largest natural range of any land mammal, besides *Homo sapiens* (Sheldon 1992), and had successfully colonised much of the Northern hemisphere (Mech 1970). Out of the 32 odd subspecies of wolves that are currently recognised (Mech 1974), two are believed to occur in the Indian subcontinent. *Canis lupus chanco* or the Tibetan wolf is found in the trans-Himalayan region and its range extends into Tibet, China, Manchuria and Mongolia. The Indian wolf *C.l. pallipes* ranges over much of peninsular India and the same subspecies is believed to occur in Iran and Israel (Mendelssohn 1982, Shahi 1982). *C.l. pallipes* is

much smaller in comparison to other subspecies of wolves, except *C.l. arabs* that is found in the Arabian peninsula.

Molecular genetic data from wolf and dog populations from around the world suggests that they belong to a closely related wolf - dog clade (Vila *et al.* 1997). Genetic analysis of mitochondrial DNA (control region and cytochrome b) of wolves from the Indian subcontinent has shown that there are three extant lineages, two of them very different from the wolf - dog clade. Wolves from peninsular India considered to be *C.l. pallipes* may have diverged from the wolf - dog clade about 500,000 years ago and are different from the *pallipes* found in the Middle East. Wolves from Himachal Pradesh to eastern Nepal (considered to be *C.l. chanco*) are basal to the other wolf clades and may have separated from them about 800,000 years ago, while wolves west of Kashmir

¹Wildlife Institute of India, P.O. Box No. 18, Chandrabani, Dehradun, Uttaranchal 248 001, India. Email: jhalay@wii.gov.in

belong to the widespread wolf - dog clade. Thus, the peninsular and Himalayan wolf lineages of India are very ancient and unique to the Indian subcontinent (Sharma *et al.*, in press).

Almost nothing is known about the ecology and status of the Himalayan wolf lineage. In these regions, persecution of wolves is common by pastoralists (Fox and Chundawat 1992), and it is likely that the Himalayan lineage would probably be one of the most endangered canids in the world. The account that follows is of the comparatively well-studied peninsular lineage of the Indian wolf (Plate 1, Fig. 1).

Adult male and female Indian wolves weigh between 19-25 kg and 17-22 kg respectively. Adult wolves measure between 103 and 145 cm from nose tip to tail tip, and between 57 and 72 cm at shoulder height. Coat colour is sandy brown with black hair tips. Some wolves have a more rufous tinge to their coats. Adult wolves can be distinguished from juveniles in the field by their size, behaviour, and white markings that develop above the eyes, on the chin and under the throat. Colour variation is rare among Indian wolves, black wolves being reported only from Ladakh. In much of the wolf's range in India, summer temperatures up to 47 °C are not uncommon, while winter temperatures occasionally approach 0 °C. In summer, most of the fur is shed, only sparse long hair remains on the wolf's body. This gives the wolf a scrawny, long-legged appearance.

Though the wolf is believed to have evolved as a temperate species, the Indian wolf is aptly adapted for living in semi-arid and hot environments. The small body size reduces food demands, permitting it to sustain its populations on smaller ungulates, lagomorphs and rodents; the shedding of under fur and behavioural thermoregulation permits this canid to live in hot and arid regions. The Indian wolf still needs ample drinking water, and in that sense is not truly adapted to desert living like the chinkara (*Gazella bennettii*).

STATUS, DISTRIBUTION AND HABITAT NEEDS

C.l. pallipes is considered endangered in India and features on Schedule 1 of the Indian Wildlife (Protection) Act of 1972 and of CITES (Shahi 1982). Killing or trading of *C.l. pallipes* is prohibited by law in India. Shahi (1982) in his preliminary survey estimated the wolf population in India to be about 800 individuals that were patchily distributed over peninsular India (Fig. 1). More intensive surveys in the state of Gujarat and Rajasthan have shown that wolf distribution is continuous in these states. The population of wolves in these two states was estimated to be between 450 and 620 (Jhala and Giles 1991). Analysis of recent surveys, coupled with the dispersal capability of wolves (Mech 1995) makes it likely that the wolf population within the states of Gujarat, Rajasthan, Haryana, Uttar Pradesh, Madhya Pradesh, Maharashtra, Karnataka and Andhra Pradesh is continuous (Fig. 1).

The current estimated distribution of wolves covers a much larger area (Fig. 1) than was reported earlier. This does not imply range extension by the wolf, but is a result of more intensive surveys and a better understanding of wolf distribution. The wolf is still far from safe in most of its range and occurs at low densities (about 1 wolf per 100-200 sq. km, Jhala and Giles 1991). High density wolf populations (up to 5 wolves per 100 sq. km) are found to occur in some habitat pockets and preserves. Breeding packs ranging from 4 to 14 wolves have been reported from the Bhal, Dwarka, Banni, and Abdasa area in Gujarat and Kutch; Kumbhalgarh, Gudda-Bishnoi, and Pali-Barmer and Jodhpur areas in Rajasthan; Nannaj, Rehukuri, Nasik, and Phaltan areas in Maharashtra; Neoradehi in Madhya Pradesh; Rollapadu in Andhra Pradesh; Melkote and Ranibennur in Karnataka; and Mahuadaur, Hazaribag and Palamau areas in Bihar (Fig. 1). Such high-density habitats are extremely important for wolf conservation, since these pockets serve as successful breeding and recruitment areas from where wolves disperse to occupy marginal habitats.

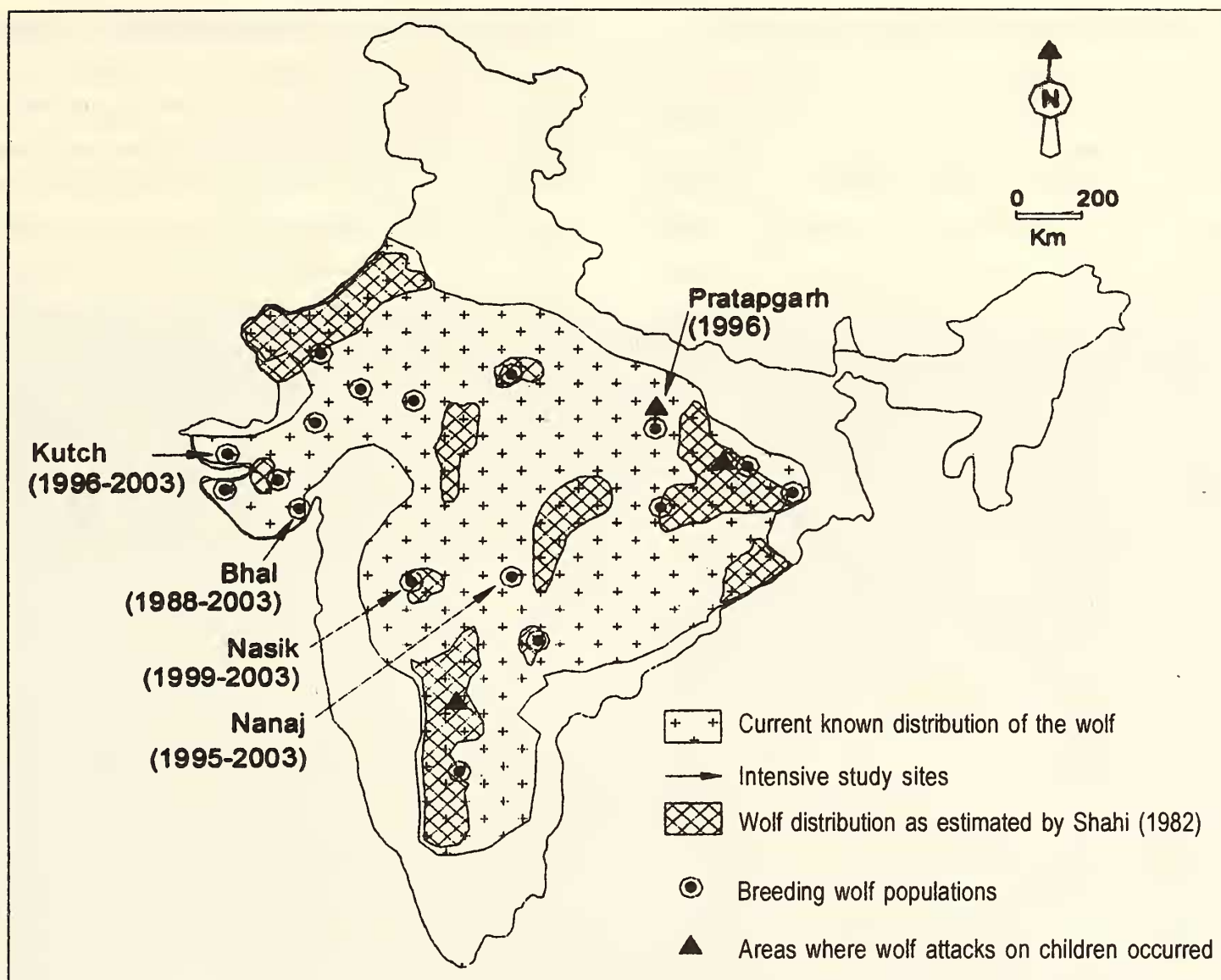


Fig. 1: Distribution of the wolf *Canis lupus pallipes* in India. Locations of known breeding populations of wolves, areas where wolf studies have been conducted and areas where wolf attacks on children have been reported are shown

In the light of current information and in concurrence with Ginsburg and MacDonald (1990), a population estimate of about 2,000-3,000 wolves for the Indian peninsula seems more realistic (Jhala 2000) and may well be a conservative underestimate.

Since wolves are believed to have evolved in boreal forest systems as predators of large ungulates, it is rather surprising that the Indian wolf rarely lives in forests and prefers scrubland, grassland and semi-arid pastoral/agricultural landscapes. The Indian wolf probably evolved during the drier spells of the Pleistocene to exploit a relatively unoccupied niche as a top carnivore of the arid zones.

The eastern population of *C.l. pallipes*, found in Orissa, Bihar and parts of West Bengal, is an exception and occurs in moister forested habitats (Shahi 1982), but even here wolves are not reported where thick forests occur. Wolves occur on the periphery of protected forest areas as is seen in Kumbhalgarh and Kailadevi Sanctuaries in Rajasthan; Panna, Kanha, and Bandhavgarh National Parks in Madhya Pradesh; and Gir in Gujarat. These peripheral areas are under heavy biotic pressure from surrounding human populations and are reduced to scrub forests. It is these scrublands that wolves primarily use.

Wolves do not seem to be restricted in their movements at night and even approach very close

to human dwellings and villages (Jhala 1991). In Maharashtra, radio-collared wolves were observed foraging in the Ojhar township of Nasik, at night. However, during the day, wolves are extremely selective in their habitat use, limiting themselves to habitat pockets that offer visual cover and shade, away from human disturbance. Such habitat pockets are crucial for denning and as rendezvous sites (areas where pups are kept after they leave the natal den), and could be in the form of broken terrain, rocky outcrops, rivulets, and grass or scrub patches. In Velavadar National Park and the rest of the Bhal area, wolves preferred to use moderately dense *Prosopis chilensis* patches (Jhala 1991; Jethva and Jhala, in prep.), while in Nanaj area wolves used forestry plantations (Kumar and Rahmani 1995); in Barmer and Pali districts of Rajasthan 'Aorans' (sacred groves) were crucial wolf habitats. In Ojhar-Nasik and near Jodhpur, airforce and military bases provide refugia for denning and rendezvous sites amongst a semi-urban landscape. In the Bhal area, where wolves were studied through telemetry for over eight years (Jhala 2001), core areas of wolf territories where dens and rendezvous sites were located were between 5-10 sq. km and were characterised by low human disturbance, good cover and presence of fresh drinking water (Jethva 2002; Jethva and Jhala, in prep.).

Wolves living in the western dry zone of India were considered to be nomadic, primarily following pastoralists during their annual migrations. However, telemetry studies in the Bhal and Kutch area of Gujarat, and in Ojhar in Nasik district of Maharashtra, have shown that Indian wolves are territorial like all the other subspecies of wolves. It seems likely that under certain ecological conditions territorial boundaries are more fluid. Territories of Indian wolves can be quite large, with profound seasonal use of only some areas within them, giving an appearance of "nomadism" to a casual observer. The area covered by a wolf that predated on children, in eastern Uttar Pradesh in 1996, was over

1,000 sq. km (Jhala and Sharma 1997). Food, water, and availability of habitat for denning and rendezvous sites are factors determining territory size (Fuller 1989, Jhala 1991). Wolves subsisting on wild prey in areas of high prey densities were observed to have small territories (100 sq. km), while wolves subsisting primarily by scavenging and by predation on domestic livestock had larger home ranges (250-300 sq. km) covering the grazing grounds of several villages. Territoriality acts as a spacing mechanism to limit the number of packs in an area. Prey density and prey size regulate pack size and territory size. These two factors act in synchrony to socially regulate wolf density in an area.

SOCIAL ORGANISATION

In canids, sociality increases with body size (Moehlman 1990, 1992). Wolves being the largest of the canids, have a highly developed social system. Wolf society is organised around the breeding or alpha pair, the alpha pair and its offspring living together as a pack. Thus, a pack is normally a family unit that may have been established by related or unrelated wolves. The pack stakes out and defends a resource territory from other wolf packs. Territorial defence is done by scent marking, howling and by actual strife between neighbouring packs (Mech 1970). As juvenile wolves mature, they either tend to disperse from their natal pack or stay back as helpers to their parents. Indian wolf pups may disperse as early as 7-8 months of age (Fig. 2). Dispersers wander in search of mates and available habitat to establish their own territories and packs, while helpers bide their time till they become breeders themselves by replacing and/or displacing their parent (Packard and Mech 1980). Telemetry data has shown packs to be quite tolerant to intruders. Single non-pack members were observed in close proximity to pack members and even shared kills on some occasions. Two packs were observed to intermingle without any



Fig. 1: The Indian wolf represents an ancient lineage of *Canis lupus* that is unique to peninsular India and parts of Pakistan. Considered to be endangered, its numbers are believed to be between 2,000 to 3,000.

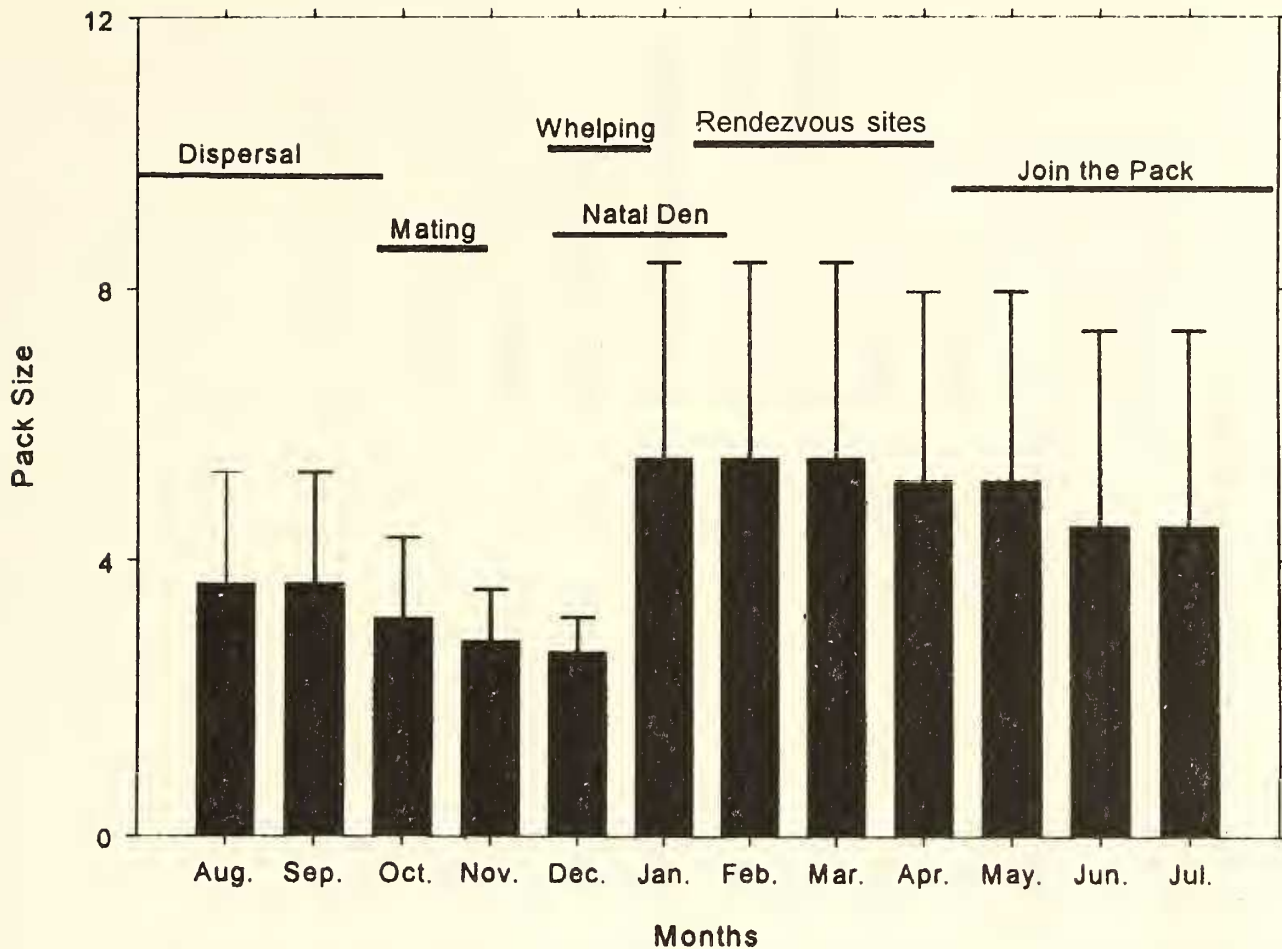


Fig. 2: Major annual events and the average monthly pack size (with standard deviation) of three wolf packs in the Bhal region of Gujarat

strife on two occasions and at one time shared the same core area for a rendezvous site. This may be an adaptation to a different set of ecological conditions, like living off clumped food resources (MacDonald 1979, Pisapio and Theberge 2000) in the form of domestic livestock carcasses, or having limited access to undisturbed habitats in a sea of human modified landscapes.

FOOD HABITS, PREDATION AND CONSUMPTION

Wolves are the top predators of blackbuck (*Antelope cervicapra*) and chinkara (*Gazella bennettii*), both medium-sized to small ungulates, in much of the arid and semi-arid areas of India (Jhala 1991, 1993, Sharma 1978). Food habits of wolves have been studied from seven different regions in India (Table 1). The majority of the wolf population in India occurs outside wildlife reserves, while wild ungulates are mostly

limited to the reserves. Most of the studies on food habits reported here (Table 1) have been done in protected areas and, therefore, overestimate the contribution of wild prey to the wolf's diet. It would be safe to conclude that the majority of wolves in India subsist on small size livestock, primarily goats and sheep (Shahi 1982, Jhala and Giles 1991).

Reduction in body size reduces food demands and permits Indian wolves to subsist even on small prey like hare (*Lepus nigricollis*) and rodents. Besides these, wolves also eat locusts, other insects, reptiles, birds, and vegetable matter, like the pods of *Prosopis chilensis* and fruits of *Zizyphus* spp. (Sharma 1978; Jhala 1993; Jethva and Jhala, in press). In Kutch, wolves were also recorded to prey on donkeys and camel calves. Wolves of Velavadar National Park subsisted almost exclusively on wild prey, even though domestic livestock were present in

Table 1: Food habits of wolves reported as percent occurrence of prey in scats or percent of kills detected from various studies in India

Location	Method	n	Livestock				Wild prey				Source		
			Sheep	Goat	Pig	Cattle	Chinkara	Blackbuck	Rodent	Hare		Others	
Bihar	Scats	130	0	30	43.1	0	0	0	0	3.1	7.7	16	Shahi 1982
Velavadar NP*	Scats	601	0.3	5	0	0.3	0	84.4	11.2	5.8	10.1		Jhala 1993
Nannaj*	Kills	175	13.6	43.8	0	0	0	42	0	0	0	0	Kumar <i>et al.</i> 1997, Kumar 1998
Rollapadu* 1997	Kills	6	33	16	0	0	0	50	0	0	0	0	Manakadan and Rahmani
Bhal	Scats	1,245	1	1.1	0	25.7	0	55.5	7.7	7.4	24		Jethva and Jhala, in press
Ojhar - Nasik	Scats	100	6.4	17.3	0	12.14	7	0	18.5	5.2	34		Jhala, unpubl. data
Lakhpat - Kutch	Scats	104	32.6	9.6	0	0	0	0	14.4	35.5	7.7		Jethva <i>et al.</i> 1997
Abdasa - Kutch	Scats	550	22	51	0	7.1	6.77	0	3	8.3	1.6		Jhala 2001
Overall food habits [#]		6	12.7	26.3	7.2	7.5	2.3	30.3	9.7	11.7	15.6		

n = sample size

*Protected areas

[#] Average computed with the exception of Rollapadu due to its low sample size

the area (Jhala 1993). Consumption by wolves preying on blackbuck was estimated at 4.62 (SE 0.11) kg/wolf/kill. Wolves killed blackbuck at an average interval of 3.5 (SE 0.5) days (Jhala 1993). Daily consumption by wolves estimated by three independent studies was 1.33 (Jhala 1993), 1.008 (Kumar 2000), and 1.80 kg/wolf (Jethva and Jhala, in press). Jethva (2002) continuously monitored three radio-collared wolf packs in the Bhal for periods ranging from 148 to 342 hours (total 1994 hours) and quantified feeding and intake rates of these packs. Wolf predation was biased towards adult male blackbuck which contributed about 70% to the total biomass consumption of these wolf packs (Jethva and Jhala, in press). Predation on domestic livestock (cattle calves) was limited to 8%, while scavenging off cattle carcasses contributed 14% to the biomass consumed (Jethva and Jhala, in press). Wolf predation was a major limiting factor responsible for shaping the age and sex structure of the blackbuck population in the Bhal (Jhala *et al.* 2001).

Larger packs (6 to 12 wolves) were recorded in areas where wild ungulate prey was abundant, e.g. in Velavadar National Park, Gudda Bishnoi, Nannaj, Dwarka and Rollapadu. In areas where domestic livestock formed the major component of the diet, pack size ranged from 1 to 4 individuals (Jhala and Giles 1991). Large numbers are more likely to be detected by vigilant pastoralists and their dogs, and may prove to be a disadvantage while hunting domestic prey. Moreover, most large domestic livestock kills are underutilised due to human disturbance to feeding wolves and a major portion of the kill is lost to scavengers like dogs and vultures. Utilisation of kills in wilderness areas by wolves is high due to lack of human disturbance.

Wolves are capable of hunting prey much larger than themselves. This is primarily achieved by hunting in packs. Wolves when hunting in packs use different "strategies" like stalking and rushing or chasing. Most chases do not last more than 0.5 km and several of the chases are

unsuccessful. Long chases of over 1 km were observed when wolves hunted blackbuck calves. Large prey is usually eviscerated and dies due to shock and blood loss. Wolves sometimes chase prey towards other pack members waiting in ambush. The technique of hunting blackbuck and chinkara by a lone wolf is by stalking, followed by a quick rush. If the prey is caught, it is normally killed by a bite on the throat or nape. The prey usually dies due to asphyxia. The majority of kills were made at night, however, during winter and monsoon, when the days were not very hot, wolves were seen hunting during daylight hours. Wolf predation is targeted towards ungulates that are old, very young or in poor condition.

BREEDING

C.l. pallipes is the only subspecies of wolf that breeds in winter. Births throughout the wolf's range seem to be well synchronised. Births in Gujarat (n=22 litters), Uttar Pradesh (n=1), and Maharashtra (n=4) occurred between December 15 and January 15. Mating occurred sometime during October to November (Fig. 2), between the dominant male and female of the pack. The mating pair is locked in a copulatory tie that lasts for 20-30 minutes (Sheldon 1992). The gestation lasts for 62-63 days (Mech 1970). The breeding (alpha) female begins excavating dens about a month to 15 days prior to whelping. It takes 2-10 days to dig a complete den, and one or more dens are simultaneously excavated. The alpha male sometimes assists in the excavation but the female does most of the digging. Dens are excavated in dry river embankments. Sometimes, fox and porcupine holes are enlarged. Hollow trunks of *Salvadora oleoides*, stacks of harvested cotton stems, and rock crevices are also used (Jhala 1991, Kumar 2000, Sharma 1978). There seems to be site fidelity for denning. Four study packs in the Bhal region and two packs in Kutch excavated dens in the same area (1 km radius) for 4-7 consecutive years, even after the alpha females of three packs

were replaced. A wolf den in the Gudda Bishnoi area near Jodhpur excavated in the hollow trunk of a *Salvadora* tree, showed evidence of use over several years. Wolf dens that we observed had oblong entrances with an average diameter of 48 cm (n=8, SE 14.5). The tunnels were about 3 m long with a single chamber at the end measuring about 1.1 m by 0.7 m, having an average height of 0.25 m and was at a depth of 0.6 m from the surface.

The mother confines herself to the vicinity of the den 5-7 days prior to birth. In wild wolves studied in the Bhal, Kutch, and Nasik, mean litter size was 4.8 (n=28 litters) and ranged between 4 to 6 pups. Pups are born blind, develop blurred vision by the age of 15 days and by 18-20 days, occasionally emerge from the den to play and nurse. At the age of about 30-40 days, the pups are normally moved to another den. They are moved between 4-5 rendezvous sites between the age of 40 days to their joining the pack at the age of 5-6 months.

Canid milk is quite dilute (Oftedal 1984). The lactating female needs to drink a lot of water so as to produce milk. Denning sites and rendezvous sites are so selected that fresh water is always available within a radius of 2 km. Water availability, remoteness from human disturbance, visual cover and shade, seem to be the critical parameters for selecting rendezvous and denning sites. At these rendezvous sites, pups may continue to use dens that are excavated by adult wolves and by the pups themselves up to the age of 5-6 months (till June/July). This behaviour has not been reported in other wolf subspecies and may be an adaptation in the Indian wolf to escape high ambient summer temperatures. After the pups left the natal den, they were rarely observed using a single den at rendezvous sites but were distributed in two or more dens. This behaviour was prominent in Kutch, where persecution of pups by herdsmen was severe. Rarely were all the pups killed when shepherds smoked wolf dens other than the natal den.

Nine rendezvous sites were used by the Velavadar pack over 2 breeding years. During the

summer (March to early June), the rendezvous sites in and around a stream bed were intensively used. The pups would spend the hot hours of the day in cool depressions dug out in the stream bank. The depressions were 25-30 cm deep and 25-50 cm wide. These dug out depressions were also used by adult wolves for lying up. The pups were restricted to an area of 250 m radius at their first rendezvous site. Wolf tracks converged from all directions along well used trails. The area smelt strongly of wolf odour and urine. Pup and adult wolf scats accumulated in and around the area. Kill remains like bones and hides were often strewn around. The description of rendezvous sites of timber wolves in North America (Joslin 1967, Mech 1970) matches extremely well with the rendezvous sites of Indian wolves. Wolf pups were taken to feed on blackbuck kills as far as 3 km from the rendezvous site, by the age of 2.5 months in Velavadar National Park.

CONFLICT WITH HUMANS

Since the majority of the wolf populations in India live outside wildlife reserves, in human dominated landscapes, they subsist primarily on livestock. A major occupation of the people in much of the wolf's range consists of livestock rearing. Large herds of cattle, sheep, and goats graze the semi-arid landscape. Most of these livestock are malnourished and die of disease and starvation. Since humans rarely consume cattle in India, much of these carcasses are available for scavenging by dogs, vultures, jackals, hyenas, and wolves. Besides scavenging, the wolf also predated on livestock like goats, sheep, and cattle calves. Wolf predation severely affects the economy of the pastoral communities that barely manage to eke out a living from the highly overgrazed and degraded landscape of semi-arid India. The pastoral community invests significantly in measures to protect their stock from wolf predation. These measures include night vigils, maintaining guard dogs, building

thorn corrals, and bringing the stock back to the village each night.

In areas with good wolf populations, average territory size would be about 150 sq. km. Considering an average stable pack size of four wolves, their density in such areas would be 2.7 wolves per 100 sq. km. Further considering that in these areas wolves would depend on small livestock (goats and sheep) to obtain about 50% of their food requirements (Table 1), a pack would predate on about 65 small livestock per year, i.e. a loss of about 43 goats/sheep per 100 sq. km. Considering an average price of Rs. 700 per small livestock, wolf predation would result in a loss of Rs. 30,000 per 100 sq. km. This would be a rough estimate of the cost of conserving wolf populations outside of protected areas. In several wolf areas in India, the State pays monetary compensation for livestock loss to wolf predation, as in Maharashtra. This practice helps negate wolf persecution by pastoralists to some extent. However, wolf predation is extremely difficult to authenticate, and paying of compensation has its difficulties in identifying false claims.

A more severe form of conflict occurs when wolves attack humans. These attacks are of two types: a) attacks by rabid wolves and b) predatory attacks on children by non-rabid wolves (Linnell *et al.* 2002). Attacks by rabid wolves are common in Maharashtra, Karnataka, Kutch, Rajasthan and Andhra Pradesh, and occur sporadically throughout the wolf's range in India. Rabid wolf attacks are rarely lethal by themselves, but could prove fatal if treatment is not provided in time. Attacks on children by wolves have been reported since British times (Blanford 1891, Lister 1917, Lydekker 1897, Pocock 1939). In recent times, such incidents have been reported from Hazaribagh in Bihar (Shahi 1982, Rajpurohit 1999), Anantpur in Andhra Pradesh, and Pavagadh in Karnataka. Jhala and Sharma (1997) confirmed attacks on children by a wolf in Jaunpur, Pratapgarh and Sultanpur districts in eastern Uttar Pradesh. Between March and October 1996, 76 children

between the ages of 2 and 9 years were attacked. Of these, over 50 attacks proved fatal. A generality that emerges from Shahi (1982) and Jhala and Sharma (1997) is that in wolf range areas where there is high human density (>600 per sq. km) with poor economic status, poor child care, with little or no wild prey around, and with low or effectively guarded livestock populations, wolves could potentially attack children. Radio-telemetry data from three different areas in western India suggests that wolves come into contact with humans very often. It would be extremely easy for wolves to attack children in these areas. However, there are no authentic reports of wolf attacks on humans in these regions, in spite of their high wolf densities. Our data suggests that attacks on children are extremely rare, considering the opportunities for attacks available to wolves, and should be viewed within their special ecological and socio-economic context (Jhala 2000). However, if and when such attacks do occur, the responsible problem wolves should be controlled immediately (either eliminated or captured), so as to prevent a public backlash against the species (Mech 1995).

THREATS AND CONSERVATION

It is indeed surprising that in spite of heavy biotic pressures on the semi-arid habitats by humans and livestock populations, and severe human - wolf conflicts, the wolf continues to survive in India. The tolerant religious and cultural attitudes of people (Boitani 1992) towards all forms of life, coupled with a low density of firearms and the absence of systematic use of poison are perhaps responsible for the continued survival of wolves in most parts of the wolf's range in India. The old value system of reverence towards life forms, and attitudes that resulted in the conservation of natural resources is, however, fast changing in rural India. Goals are becoming monetary and actions exploitative. "Wastelands" and communal grazing lands are rapidly being

developed for agriculture and industry. Dry farming, which is conducive to the survival of the wolf, is being rapidly replaced by irrigation and intensive farming with multiple cropping. Such intensive agriculture areas no longer support wolf populations (Jhala and Giles 1991).

Wolves were severely persecuted during the British rule in India. Bounties offered for wolves were higher than those offered for leopards (Richards 1914). This attitude persisted till the 1970s and wolves were eliminated even from the current Velavadar National Park area to reduce predation on blackbuck (Ranjitsinh 1982). Though wolves are still shot illegally in some parts of their range, hunting currently does not pose a serious threat to the survival of the species. Pastoralists and farmers smoke and dig out dens to kill wolf pups (Shahi 1982, Jhala and Giles 1991). Most wolf populations could sustain these losses due to their high fecundity rates. Recently there have been cases of poisoning of entire wolf packs in Rajasthan and Kutch. This is an alarming trend, since poison can wipe out wolves and the entire carnivore guild from an ecosystem, and needs to be dealt with severely. Poison has been the primary cause of wolf extermination throughout the world. Human attitudes and persecution of wolves is related to the amount of livestock damage caused by wolves. In Kutch, where wolves subsist primarily on livestock, attitudes are more hostile and human-caused mortality of wolves higher in comparison to the Bhal where wolves subsist on wild prey. Schemes like Maharashtra state's compensation for wolf-killed livestock help reduce persecution of wolves to some extent, but create claim-authentication difficulties.

The major threat to surviving wolf populations in India is loss of habitat resulting in depletion of natural prey densities and non-availability of appropriate denning and rendezvous sites. Wolves do breed in suboptimal habitats, but recruitment is negligible due to human-caused mortality of pups. In such areas,

human - wolf conflict is heightened as wolves are forced to subsist on domestic livestock. As human values become more monetary and societies opt for quick short-term economic gain, such "wastelands" become prime targets for development of industry and intensive agriculture. Intensive agriculture, especially when irrigated by deep bore wells powered by electricity in the arid and semi-arid areas, is unsustainable in the long run. Once ground water reserves are depleted by pumping out, intensive agriculture fails. Unfortunately, this process may take decades and irreplaceable damage would have been done to endangered fauna and the ecosystem drastically altered. More permanent damage is likely to occur, to flora and fauna adapted to arid conditions, by large irrigation schemes like the Narmada Project, which will alter the land use patterns and ecosystems over several landscapes. In the rush towards short-sighted and quick economic gain, society and decision makers are not willing to consider even meagre compromises to address and incorporate conservation goals into the long-term planning process.

Recent research has identified yet another threat: canine distemper and rabies. Distemper had wiped out the entire litter of pups for 2 consecutive years (1993-94) in Velavadar National Park. Distemper is contagious and affects pups and juvenile canids, causing mortality in most of those affected. Rabies is of special concern since rabid wolves are known to attack people throughout their range (Linnell *et al.* 2002). A rabies outbreak in Kutch, in 2001-02, killed most members of my study packs. The wolves, however, showed good resilience and within a year repopulated these vacant territories. This was possible due to their dispersal ability (Mech 1995) and because wolf distribution is continuous with good source populations. Feral dogs, along with other wild canids like jackals, spread these diseases. Wolf - dog interactions are common in India. Wolves interact with feral dogs at kills and feeding sites. Wolves occasionally kill and eat dogs (Jhala 1991).

Besides distemper and rabies, dogs also transmit other diseases like parvovirus, hepatitis, and a multitude of other infections to wolves (Jhala 1991, Goyal *et al.* 1986, Mech 1970).

Indian wolves can hybridise with dogs in captivity. However, none of the wild wolves (n=45) screened by us had dog mitochondrial haplotypes, nor did dog samples from wolf territories have wolf haplotypes. This suggests that hybridisation events may be extremely rare in the wild and do not pose a threat to the wild wolf gene pool (Sharma *et al.*, in press).

A proposed national wolf conservation strategy included the following points: 1) encouraging public support and education, 2) enforcing legal protection, 3) paying compensation for wolf-killed livestock, 4) conducting surveys of wolf populations and research on the dynamics of select populations, 5) protecting breeding habitats, and 6) eradicating feral dogs from wolf conservation areas (Jhala and Giles 1991). Fig. 1 shows sites that have confirmed breeding populations of wolves. These sites are well dispersed throughout the wolf's range and many of them are in protected areas. Some of the areas that have confirmed breeding packs but no legal status should be offered some level of protection, especially during the breeding season (December to March). Further development in these areas should be discouraged. Wolf conservation is not incompatible with other land uses. Such areas could be promoted for multiple use, including controlled livestock grazing and dry farming. It is essential that remote habitat patches should be left intact in these areas for wolves to use as denning sites, rendezvous sites and resting areas (Jhala 1995). These core areas need not be of any great size, 5-15 sq. km undisturbed patches of good habitat (cover and fresh water are critical) seem to be sufficient for a pack to breed

successfully (Jethva and Jhala, in prep.). Public attitudes towards the wolf in the rest of the world are rapidly improving. Wolves have in the recent past colonised areas from which humans had previously extirpated them. Such recolonisations have occurred naturally as in Scandinavia, Germany and France (Promberger and Schroder 1993), or were aided by humans as in Idaho (Fritts 2000) and Yellowstone National Park (Mech *et al.* 1995), and in the case of red wolves (*Canis rufus*) (Kelly *et al.* 2000) and Mexican wolves (*C.l. baileyi*) (Brown and Parsons 2000).

Though the wolf has probably survived in the Indian subcontinent for the past 500,000 years, its continued existence in the next 100 years is questionable. The wolf is a survivor, and does not face many of the small population problems associated with insularization that spell doom for large carnivores. With the correct attitudes and actions, we should be in a position to ensure its future.

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